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EXECUTIVE SUMMARY

STUDY OF EMISSIONS IMPACT OF SELECTED AFTERMARKET PARTS

ARB CONTRACT NO. A0-138-32

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ABSTRACT

This study was conducted to determine the volume and pattern of sales of selected aftermarket parts in California, the differences in emissions, fuel economy and driveability between vehicles in the unmodified and modified states, and the factors which contribute to changes in emission levels. A survey of manufacturers/distributors and users of the aftermarket parts was conducted to determine the volume and pattern of sales. Four vehicles were obtained for testing. Two vehicles were used to evaluate exhaust headers and aftermarket intake manifolds. The other two vehicles were used to evaluate turbochargers. One vehicle from each group was used to evaluate the aftermarket parts in a "worst case" configuration, i.e. with a number of emission control components removed or disabled. The "worst case" configuration was representative of aftermarket parts which did not provide for reinstallation of emission control components and/or those persons installing aftermarket parts who would choose not to reinstall emission control components. The other vehicle from each group was used to evaluate the aftermarket parts in a "best case" configuration, i.e., with original emission control components installed and operating. The "best case" configuration was representative of aftermarket parts which provided for reinstallation of emission control components and those persons who would choose to reinstall those componenents if the aftermarket parts provided for their reinstallation. In the "worst case" configuration emissions increased substantially and fuel economy was generally improved, compared to original equipment configurations, by use of aftermarket parts. In the "best case" configuration emissions were increased slightly or were decreased, compared to original equipment, by use of aftermarket parts and fuel economy was generally increased.

ACKNOWLEDGEMENTS

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DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement for use or non-use of such products.

Executive Summary

PROGRAM OBJECTIVES

Section 27156 of the California Vehicle Code requires that any add-on or modified part which alters or modifies the original design or performance of a vehicle's emission control system be exempted by the Air Resources Board before it can be legally sold for installation on on-road motor vehicles. The devices of particular concern, due to their potential adverse effect on emissions, are the following:

- replacement carburetors
- headers
- modified camshafts
- modified intake manifolds
- modified distributors
- turbochargers

These devices are often installed on recreational vehicles or "high performance" street vehicles and in some cases necessitate or encourage the removal of one or more emission control devices. For example, headers encourage catalyst removal and usually result in elimination of heated air intake and air injection ports. Headers may also affect the performance of back pressure modulated EGR valves and choke operation. The numbers of such devices sold and installed illegally and their impact on emissions has not been determined.

The purpose of this study was to determine the volume and pattern of sales of selected aftermarket parts in California, the differences in emissions between vehicles in the unmodified and modified state, and the factor(s) which contribute to changes in emission levels. The results of this study will be used to assess the impact of selected aftermarket parts on motor vehicles emissions and the need for control measures.

SCOPE

The program was divided into three tasks, as follows:

Task 1: Survey of device sales and usage
Task 2: Testing to determine the impacts of aftermarket parts
Task 3: Analysis of data from Tasks 1 and 2 and preparation of the Final Report

Task 1 consisted of surveys of manufacturers/distributors and users of the six aftermarket parts listed in the program objectives. The survey sought to define the sales level and vehicle application of these aftermarket parts. Task 2 consisted of performing comparative (stock original equipment versus aftermarket) tests on two (2) vehicles which were equipped with headers and modified intake manifolds; and comparative tests on two (2) other vehicles which were equipped with turbochargers. The comparative tests entailed measurement of driveability demerits using the ARB's driveability procedure; and exhaust emissions and fuel economy during urban, highway, and steady speed driving modes. The Federal Test Procedure (FTP) was used for the urban driving mode. The Highway Fuel Economy Test (HFET) was used for the highway driving mode. The steady driving modes were 20, 30, 40, 50 and 60 mph at FTP road loads. During the steady speed tests, emissions, temperature and pressure were recorded to show the affect of the aftermarket part compared to the stock original equipment configuration. Task 3 consisted of an analysis of the collected data and a written report.

EXPERIMENTAL DESIGN

The test parts and vehicles tested were selected on the basis of the survey of sales and usage. Four vehicles were tested. Two vehicles were tested with headers and manifolds and two vehicles were tested with turbochargers. One vehicle in each group was tested in a configuration which retained related original equipment emission control components to the extent possible, when the aftermarket parts were installed. This configuration simulated the expected "best case" use in terms of impact on exhaust emissions. The other vehicle in each group was tested in a configuration in which related original equipment emission control system components were removed or disabled when installing the aftermarket parts to simulate the expected "worst case" use in terms of impact on emissions.

The test protocol consisted of baseline testing to determine whether each vehicle met the applicable emission standards. However, three of the four vehicles exceeded at least one of the three measured emission standards. The selected parts were then installed and the test sequence repeated. Headers and manifolds were tested using the FTP, HFET and driveability tests. In addition, steady-state tests were performed at 20, 30, 40, 50 and 60 miles per hour. Turbochargers were tested using the FTP, HFET and steady-state tests, all at normal road load and, for the Corvette only, at twice normal road load. The VW overheated and could not be tested at twice or even 1.5 times normal road load.

RESULTS

Survey of Device Sales and Usage

The survey of aftermarket parts industry firms was expected to provide an estimate of the annual unit sales in California for each type of aftermarket part. Unfortunately, the response rate was poor and the annual sales estimates shown below are somewhat uncertain.

Part Type		Estimated Annual Sales (1981)
Headers	-	68,000
Modified intake manifolds	-	32,000-40,000
Turbochargers	-	.2,000
Modified distributors	-	50,000
Camshafts	-	66,000
Carburetors	-	27,000

The most common engine on which parts were installed were the small block Chevrolet V-8 (305, 327, 350 CID). The only significant exception was for turbochargers which were frequently installed on 4 cylinder engines. Most of the vehicles (80%) on which aftermarket parts were installed were registered for street use but most vehicles were not the owner's primary vehicle. Almost 60 percent of the automobiles owned by survey respondents had 2 or more of the selected aftermarket parts installed.

Exhaust Headers Compared To Original Equipment

The worst case aftermarket exhaust header configuration used in this program increased all three of the measured exhaust emissions by a minimum of 25%, improved fuel economy 10%, degraded cold driveability, and improved acceleration (0-70mph) time by four seconds compared to the stock original equipment configuration. The best case exhaust header configuration increased hydrocarbon (HC) emissions by 21%, decreased carbon monoxide (CO) emissions by 41%, and did not significantly change oxides of nitrogen (NO_x) emissions. Fuel economy improved 41% while driveability was degraded, but acceleration time decreased five seconds during the 0-70 mph acceleration.

Modified Intake Manifolds Combined With Exhaust Headers Compared to Original Equipment

Modified intake manifolds were tested in combination with the aftermarket exhaust headers. For the best case manifold/header package, HC emissions increased 152%, CO and NO_x emissions decreased approximately 30%, fuel economy increased 23%, driveability was degraded and acceleration time decreased 2 seconds. For the worst case manifold/header configuration, HC emissions increased 266%, NO_x emissions increased 107%, CO emissions were not significantly affected, and fuel economy increased 21%. Driveability improved considerably and acceleration times decreased 5 seconds.

Turbochargers Compared to Original Equipment

Turbochargers were tested alone. For the best case turbocharger configuration, a California exempted kit was used. Hydrocarbon (HC) emissions increased 12%, CO emissions increased 52%, NO_x emissions decreased 26% and fuel economy decreased 22% on the FTP and 15% on the HFET. For the worst case turbocharger configuration, a non-exempted kit was used and the catalytic converter was removed. All three exhaust emissions increased several fold and fuel economy was marginally improved. Driveability evaluations of the turbochargers were not conducted.

CONCLUSIONS

The following general conclusions can be drawn from this study:

- Aftermarket parts sold in California are generally used on vehicles registered for street use.

- The sales volume of aftermarket parts is ranked in the following order:

  headers > camshafts > distributors > intake manifolds > carburetors > turbochargers

- Aftermarket parts can cause significant adverse emissions impact when their use causes removal or inoperability of emission control components.

- Installation of currently marketed parts, such as those evaluated in this study, increases at least one of the three regulated exhaust emissions and generally degrades driveability. Fuel economy was generally improved with the use of headers/manifolds, however, it is important to note that the fuel economy percentage increase observed in this study was much greater than typical.

- There is insufficient data to draw meaningful conclusions from pressure measurements in terms of predicting emissions impact of aftermarket turbochargers or in establishing the factors contributing to emissions impact.

- The temperature and pressure measurements taken revealed that headers/manifolds do change the operating characteris tics of an engine. Although emissions generally increased with after market parts usage, the increase was attributable to the effect these parts had on installation or function of other emissions related components; i.e., carburetors, EGR valves, secondary air, catalysts, etc.